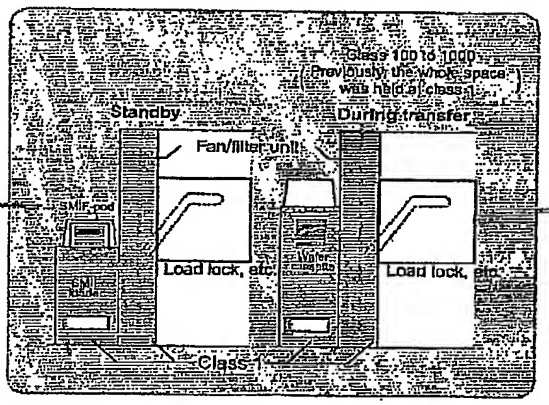

Mini-Line and SMIF
The concept of the Mini-Line is to improve the ability of the production capacity to respond to demand, and to allow maintenance to be performed flexibly by providing multiple small-scale lines instead of a single large-scale production system. The Mini-Line and SMIF, two production revolutions, are combined at Sony's Fab1.

been experiencing troubles with SMIF, and we had heard that other Japanese semiconductor manufacturers had doubts and were planning on waiting and seeing how Sony did. Which is to say, we saw SMIF as a challenge. Since there would be no turning back once Sony's leaders gave the word, we knew there would be no avoiding the issue.

I've heard that this was called the "N project" since it is located in Nagasaki. What were the most difficult problems you faced in the first year after the plant came online?

Although you may think that all one needs to do is buy pods and loaders and connect them to the manufacturing equipment, it's actually very difficult. First, to attach standard loaders to equipment, such as washers, diffusers, RIE, and CVD units, with differing external dimensions required matching the dimensions of the acrylic mediation units with FFUs (power bezels) to each unit. In addition, we had to verify strictly both that the loader internal air flow was not disturbed, and that it was at a positive pressure (i.e. that the air pressure was higher than the external air pressure and thus dust entry was prevented) for each of around 400 loader units individually. To bring the SMIF system online, we brought 15 or 16 engineers from the US. However, there were major linguistic and cultural problems. It took us a long time to get them to understand that strict deadlines were required and to work closely with Sony engineers.

What has been your feeling for the completed system?

It is close to ideal. When we measured how many dust particles got on a wafer, we found on average 0.3 particles per 100 transport operations. This is essentially a zero dust state.
The following is symbolic of SMIF performance. While we were running the line we had installed first to produce test samples, we transported in and installed the equipment for the next line right next to first line. This included opening up holes in the floor. Furthermore, we didn't even install partitions; we merely strung ropes so that no one would fall in. Despite all this, there were no problems due to dust. This would be unthinkable in any previous line.

The mini-environment technology is also being adopted at the CCD and LCD factory currently under construction in Kikuyo-machi in Kumamoto Prefecture. Since this will be a 300 mm diameter wafer line, the FOUP system used will be different from the SMIF system at Fab1, which is a 200 mm wafer line. Mr. Kisakibaru and his associates are now applying the technology and know-how developed at Fab1 to construct another, superlative line.

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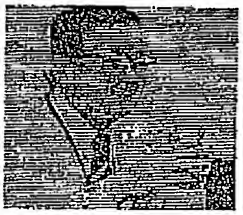
Microelectronics

The Changing Cleanroom

SMIF Clean Minienvironment Technology

Introduced at Fab1 in Nagasaki. The first full adoption in a new line in Japan.

**The image of dust being the problem is no longer appropriate.
With the current microscopic feature sizes in semiconductor processes,
contamination even at the molecular level can adversely affect product quality.
As a result, interest is shifting from maintaining a fixed level of cleanliness
in the whole room in which the semiconductor equipment is installed
to thoroughly controlling the local space (minienvironment) around the wafer.
SMIF: Standard Mechanical Interface.
This technology was adopted throughout a complete line for the first time
at Sony Computer Entertainment's Fab1 line in Nagasaki,
a dedicated facility for manufacturing embedded DRAM logic LSIs
for PlayStation2 that went on line in April 2000.
We spoke with Toshiro Kisakibaru about the process of this introduction.**



Toshirou Kisakibaru
Manager
Production Technology Development Department
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Conventional Clean Room (All Down Flow)
Air flows down from the ceiling and dust is removed to the floor. If the air flow is stable, class 1 is guaranteed. However, since the air flow can be disturbed by the way the equipment is installed or by personnel movement, it is difficult to maintain a consistent clean level.

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SMIF Introduction (Minienvironment) * An example of a multiple type
A pod that holds multiple wafer cassettes is placed in the loader (standby). At transfer time, only the pod is lifted up, and the cassettes are taken up from within the loader to the manufacturing equipment directly. Air from which chemicals have been removed is used to maintain the inside of the loader at class 1. The outside of the loader can be at class 1000 without affecting quality.

I've heard that SMIF was first used in Japan in 1985. Why was it not adopted immediately?

At that time "all down flow," that is the technique of maintaining cleanliness throughout a large space, was thought appropriate for use as the leading-edge semiconductor manufacturing environment. As a result, there simply wasn't much interest in SMIF.
Originally at that time SMIF had many problems, including the emission of high molecular weight gasses from the seal material of the pods (cases used to transport and store wafer cassettes), and disturbance of the air flow within the loader (the robot used to store and retrieve wafer cassettes) resulting in dust contamination. As a result, SMIF was adopted to a limited extent when lines were expanded, but never to the extent of using SMIF throughout a complete line.

Does that mean that full-scale adoption only began to be considered when quality and reliability were improved?

Well, yes. However, at the micro-fabrication levels used up to the present, conventional cleanrooms have been adequate, so it has been generally thought that the use of open cassettes, without going to the effort of enclosing the wafers in a pod, was adequate. However, when the design rules reach the 0.18 μm level, as they have at the Fab1 facility, ideally dust down to a 0.018 μm diameter, that is, one tenth of the design rule, should be considered a problem. However, due to requirements imposed by test equipment during testing, cleanliness is managed down to the level of dust one third the size of the design rules, namely particles with a diameter of 0.06 μm. Still, this is already at the molecular level. For devices with design rules smaller than 0.18 μm, the high molecular weight gasses emitted from building materials, cable insulations, and other organic materials can adversely affect device characteristics and reliability. It would be extremely difficult to implement measures to deal with this sort of chemical contamination for 10,000 to 20,000 square meter cleanrooms. Thus we think that it should be easier to manage cleanliness over limited areas.

Did you have any doubts or misgivings about introducing this approach in a full line for the first time in Japan?

First of all, a shortage of semiconductor device manufacturing capacity was forecasted in 1998, and we had already undertaken a feasibility study for the construction of a new building. In that study, we assumed we would use 300 mm wafers and Front Opening Unified Pods (FOUPs). Thus we were already prepared psychologically when decisions, which presupposed the introduction of SMIF at Fab1, were made at the end of 1998. However, we had already received reports that manufacturers outside Japan had